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### (54) EXCHANGEABLE GUIDEWIRE

AUSTAUSCHBARER FÜHRUNGSDRAHT

GUIDE POUR CHANGEMENT DE CATHETER

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**Description****Background of the invention**

The present invention relates to devices employed in catheter guiding and exchanging procedures, and more particularly to guidewire and exchange wire interconnection apparatus.

Catheterization procedures, e.g. percutaneous transluminal angioplasty catheterization (PTCA), involve insertion of catheters into blood vessels and other body passageways. Frequently such passageways are convoluted, giving rise to difficulties in inserting the catheters. Accordingly, guidewires are employed to insure accurate positioning of body-inserted catheters.

More particularly, a guidewire is inserted and maneuvered along arterial or other passageways to the desired treatment site, leaving a proximal portion of the guidewire outside of the patient. Next, the catheter is threaded onto the guidewire proximal portion, which is received into a lumen formed in the catheter. The catheter is advanced over the guidewire, and thus guided to the desired treatment site. Typically the guidewire is at least slightly longer than the catheter, so that when the catheter is completely advanced to the treatment site, at least part of the guidewire proximal end portion protrudes from the catheter. For example, for a catheter length of 130 centimeters, the guidewire length can be about 150 centimeters.

Frequently in catheterization, the need arises to exchange catheters. Preferably the exchange is accomplished with the guidewire remaining in place, to avoid the need to maneuver yet another guidewire to the treatment site. An exchange requires gripping the guidewire proximal end portion to maintain its position while the catheter is removed in the proximal direction. However, well before the originally inserted catheter can be withdrawn in this manner, it completely covers the guidewire, and the physician or other user can not simultaneously maintain the guidewire and proximally move the catheter.

In view of this difficulty, the usual approach has been to remove the guidewire from the patient, leaving the originally inserted catheter in place to guide the advancement of an exchange wire to the treatment site. The exchange wire is substantially longer than the guidewire. The proximal portion of the exchange wire, remaining outside of the patient after complete insertion, is longer than the length of the catheter. Thus, the exchange wire can be maintained while the catheter is completely withdrawn from the patient. After a replacement catheter is inserted over the exchange wire, the exchange wire is removed and the guidewire reinserted.

The repeated advancing and withdrawing of guidewires and exchange wires presents undue risk of trauma to the blood vessels or other lumens, and increases the complexity and required time for the catheterization procedure.

Several guidewire and exchange wire coupling

schemes have been proposed to avoid the need for the wire exchanges. For example, U. S. Patent No. 4,917,103 (Gambale et al) and U. S. Patent No. 4,922,923 (Gambale et al) disclose a guidewire and exchange wire interconnection system. A hollow tubular fitting is provided at the proximal end of the guidewire, while a reduced diameter tip is formed at the distal end of the exchange wire. With the distal tip inserted into the tube, the tube is crimped to form a permanent coupling of the wires.

U. S. Patent No. 4,966,163 (Kraus et al) shows an extendable guidewire including a main section and an extension section. A releasable coupling of these sections is provided by an externally threaded male contact at the proximal end of the main section, and an internally threaded female contact at the distal end of the extension section. The female contact is mounted to rotate relative to the extension section.

Yet another coupling scheme is disclosed in U. S. Patent No. 4,827,941 (Taylor et al). A guidewire assembly includes a main section with a reduced diameter undulating (sinusoidal) male contact at its proximal end. An extension section includes a tube at its distal end. The sinusoidal contact elastically deforms as it is inserted into the tube, to provide a friction fit. A similar approach is shown in U. S. Patent No. 4,958,642 (Christian et al). Another friction fit approach is disclosed in U. S. Patent No. 4,875,489 (Messner et al). A main section of an extendable guidewire has a tapered proximal end. An auxiliary section of the guidewire has a tube at its distal end. The tube has a longitudinal gap, and thus expands to receive the tapered end of the main section and resiliently retain the tapered end once inserted.

More specifically, U. S. Patent No. 4,875,489, which is considered to represent an example of the closest state of the art with respect to present Claims 1 and 38, discloses an interconnection apparatus for body insertable guidewires and exchange wires, including: a first connector at one end of a first wire, said first connector being substantially symmetrical about a first connector axis and having a first end region and a recessed region adjacent the first end region; and a second connector adapted for mounting at one end of a second wire, said second connector having a second connector axis; wherein the first and second connectors, when positioned in confronting and at least generally axially aligned relation, are movable axially toward one another into a mechanical coupling.

While the above approaches perhaps are an improvement as compared to multiple wire exchanges, each encounters difficulties, particularly in connection with smaller guidewires and exchange wires, which can have diameters as low as ten one-thousandths of an inch (0.025 cm).

Therefore, it is an object of the present invention to provide a single device for performing the functions of the guidewire and the exchange wire in catheterization procedures.

Another object of the invention is to provide a sim-

ple and reliable means for releasably coupling a guidewire and an exchange section proximal to the guidewire.

A further object is to provide a guidewire/exchange wire system with separate guide and exchange sections releasably coupled to one another in a manner that prevents the transfer of torque from one section to the other.

Yet another object is to provide a guidewire with complementary contacts for coupling an exchange section to a guide section of the guidewire, in a manner that affords a tactile sense of completing the connection.

#### Summary of the Invention

To achieve these and other objects, there is provided an interconnection apparatus for body insertable guidewires and exchange wires as defined in claims 1 and 38. The apparatus includes a first connector fixed to one end of a first wire. The first connector is substantially symmetrical about a first connector axis and has first and second axially opposite end regions. In a preferred embodiment a groove is formed in the first connector between the end regions. A second connector, fixed to one end of a second wire, has a second connector axis and a projection means. The first and second connectors are positionable in confronting and axially aligned relation, for axial movement of the connectors relative to one another toward a mechanical coupling. When the connectors are mechanically coupled, the projection means extends radially into the groove. At least one of the connectors is elastically deformable to allow passage of the projection means axially inward past one of the end regions and into the groove as the connectors are moved axially relative to one another. Once the projection means has passed that end region and resides within the groove, the end regions tend to confine the projection means within the groove to prevent any substantial axial movement of the connectors relative to one another away from the mechanical coupling.

Preferably the first and second connectors, when mechanically coupled, are rotatable relative to one another about the first connector axis. This prevents the transfer of torque from one of the wires to the other, and thus reduces or eliminates torsional stress that otherwise can lead to kinking or damage, particularly for wire sections of small diameter, e.g. ten mils (0.025 cm).

To achieve a releasable coupling, the flexible connector further is elastically deformable to allow axially outward passage of the projection means away from the groove and past the first end region of the first connector, thus to disengage the first and second wires.

In one preferred version of the interconnection apparatus, the first end region is a truncated cone that diverges in the axial direction toward the groove, and the second end region is a shank on the opposite side of the groove from the cone. The outside diameter of the shank and the maximum outside diameter of the truncated cone are substantially equal, both being greater than the outside diameter of the groove. The complementary second connector is a socket having an annular wall, with the projection means comprising four indentations formed in the annular wall along a medial region of the socket. The indentations are angularly spaced apart from one another by 90°, to form two pairs of opposed dimples or nodules at the medial region of the socket. The diameter of the truncated cone and shank is greater than the distance between each pair of nodules. Consequently the socket yields along its medial region to allow passage of the truncated cone, to position the nodules within the groove. Once the truncated cone is past the nodules, they are captured within the groove. The truncated cone and shank cooperate to maintain the nodules in the groove, and thereby maintain the mechanical coupling of the connectors.

The outside diameter of the groove can be selected with reference to the distance between opposed nodules, to permit a substantially free rotation of the socket relative to the first connector. This prevents any substantial transmission of torque from one of the wires to the other.

In practice, the first connector (a distal pin) is formed into the exchange wire at its distal end, with the socket fixed to the proximal end of the guidewire. With the guidewire inserted into the patient and with its distal tip at the treatment site, the proximal end portion of the guidewire, including the socket, remains outside of the patient. The exchange section of wire is coupled to the guidewire by sliding the first connector distally into the socket, until the projecting nodules and groove are axially aligned.

As mentioned, some elastic deformation of the socket is required to permit the projections to clear the truncated cone. Clearance of the cone leads to at least partial return of the socket to its normal, unstressed configuration, which gives the user a tactile sensation of the mechanical coupling.

Thus, the combination of the pin connector and socket connector provide for a reliable, releasable, and repeatable mechanical coupling of guidewire and exchange sections. The coupling is achieved by simple relative sliding of the pin connector and socket connector, and entry of the protrusions into the groove signals a physician or other user that the coupling is accomplished. The same type of motion, i.e. relative sliding of the connectors, disengages the mechanical coupling. Thus, connecting and disconnecting the wire sections demands relatively little attention on the part of the physician, who then is able to devote most of his or her attention to the catheterization procedure at hand.

#### In the Drawings

For a further understanding of the above and other features and advantages, reference is made to the following detailed description and to the drawings, in which:

Figure 1 is a side elevation of a guidewire assembly including connected guide and exchange sections constructed in accordance with the present invention;

Figure 2 is an enlarged side elevation of a distal end region of the exchange section;

Figure 3 is an enlarged side elevation of a proximal end region of the guide section;

Figure 4 is a proximal end view of the guide section;

Figure 5 is a sectional view taken along the line 5-5 in Figure 4, with a socket connector of the guide section shown removed from the remainder of the guide section;

Figure 6 is a sectional view taken along the line 6-6 in Figure 5;

Figures 7-9 are diagrammatic views illustrating progressive insertion of a pin connector of the exchange section into the socket;

Figure 10 is an end view of an alternative embodiment socket connector; and

Figures 11-15 illustrate an alternative embodiment guidewire including pin and socket connectors.

#### Detailed Description of the Preferred Embodiment

Turning now to the drawings, there is shown in Figure 1 an exchangeable guidewire 16. The guidewire includes two releasably coupled sections: a guide section 18 and an exchange section 20. Sections 18 and 20 preferably are constructed of stainless steel, for example a type of steel known as "No. 304" stainless steel, each being approximately 150 centimeters in length. Guide section 18 and exchange section 20 have the same diameter, which preferably is in the range of from about 0.010 inches (0.025 cm) to about 0.060 inches (0.15 cm). Guide section 18 has a distally converging distal tip 22, and a socket connector or sleeve 24 at its proximal end. Exchange section 20 has a proximal end and a distal end removably inserted into socket 24.

The distal end region of exchange section 20 is shown in Figure 2. A portion of the stainless steel wire at the distal end is selectively removed, to form a pin connector 28. More particularly, material is removed by a precision grinding of the exchange section by relative rotation of the exchange section and a grinding tool (not shown) about a central longitudinal axis 30 of the exchange section. As a result, pin connector 28 is concentric on axis 30, and transverse profiles, i.e. profiles taken perpendicular to axis 30 along the connector, are circular.

Pin connector 28 has a distal tip or head 32 in the form of a truncated cone, diverging in the proximal direction from a blunt distal end 34 to a maximum cone diameter at 36. This divergence is gradual, in the sense that the angle between the inclined cone surface 38 and axis 30 is less than 45°, and more preferably about 20°. Connector 28 further includes a proximal shank 40, having an outside diameter substantially equal to the maximum diameter of cone 32. Between shank 40 and the

remainder of exchange section 20 is an inclined surface 42.

Pin connector 28 further includes an annular recess or groove 44, formed along an intermediate region of the connector between shank 40 and cone 32. Over most of its length, groove 44 has an annular surface 46 concentric on axis 30. On opposite sides of surface 46 are inclined groove surfaces 48 and 50 near the shank and cone, respectively. Surfaces 48 and 50 are steeply inclined, in the sense that the angle of each surface with respect to axis 30 is at least 45°.

Figure 3 shows the proximal end region of guide section 18, including socket connector 24 and a proximal end of the wire forming the guide section. Socket connector 24, over most of its length, has an annular wall in the form of a hollow, circular cylinder. However, at its medial region 54, socket connector 24 is formed to provide four indentations projected inwardly toward a longitudinal central axis 56 of the socket connector.

These indentations provide nodules or dimples, formed angularly spaced apart from one another at 90° intervals. Thus, there are two opposed pairs of the nodules, one including nodules 58 and 60, and the other pair including nodules 62 and 64 (Figure 4).

As perhaps best seen in Figure 5, the distance "a" between the pair of indentations 58 and 60 is less than the nominal inside diameter "b" of socket connector 24 over the majority of its length. The same is true for the distance between indentations 62 and 64. At the distal end of the socket connector is an annular beveled surface 66.

Further in Figure 5, the proximal end of the guide section is withdrawn from the socket connector to reveal a proximal extension 68 having an outside diameter approximately equal to but slightly less than inside diameter "b" of the socket connector. Between extension 68 and the remainder of guide section 18 is an annular beveled transition surface 70. Socket connector 24 is permanently secured to guide section 18, by an interference fit of extension 68 within socket connector 24, with parallel beveled surfaces 66 and 70 contiguous. Preferably an adhesive is applied to at least one of surfaces 66 and 70 before the socket connector and guide section are engaged, in which case the adhesive further secures the connection.

The maximum cone diameter and the shank outer diameter, indicated respectively at "c" and "d" in Figure 2, are approximately equal to one another, greater than distance "a" between indentations 58-64, and less than inside diameter "b" of socket connector 24. An outside diameter of groove 44, indicated at "e" in Figure 2, likewise is less than diameters "c" and "d", and preferably is about equal to distance "a".

Pin connector 28 and socket connector 24 provide for a releasable mechanical coupling of the exchange and guide sections, in which the socket connector surrounds the pin connector, indentations 58, 60, 62 and 64 are aligned with and captured within groove 44, and axes 30 and 56 substantially coincide. The joiner of

connectors 24 and 28 is illustrated in Figures 7-9. As seen in Figure 7, conical head 32 of the pin connector is inserted into the proximal end of socket connector 24, then moved distally toward indentations 58-62. This insertion is facilitated by the fact that the cone diameter, near distal end 34, is substantially less than the distance "a" between opposed indentations, and thus is substantially less than the interior diameter "b" of the socket connector.

As pin connector 28 is moved rightward as viewed in Figures 7-9, cone 32 eventually encounters the indentations. Further rightward movement of the cone elastically deforms socket connector 24 particularly along medial region 54. Thus, surface 38 of cone 32 functions as a cam, forcing indentations 58-64 apart from one another against the elastic restoring force of the socket, until the maximum diameter portion of the cone is axially aligned with the indentations, as viewed in Figure 8. The gradual (20°) incline of cone surface 38 facilitates insertion of connector 28. More particularly, due to the gradual incline, the required axial insertion force is relatively small as compared to the radial force required to elastically deform the socket connector.

When pin connector 28 is inserted beyond the position illustrated in Figure 8, indentations 58-64 move radially inward due to the elastic restoring force of the socket, into an engagement with groove surface 46. This movement is relatively rapid, due to the steep incline of groove surface 50 and the restoring force. The rapid movement and engagement provide a tactile sensation to the physician or other user attempting to connect the extension and guide sections, that a mechanical coupling has been achieved.

As shown in Figure 9, when connectors 24 and 28 are coupled, indentations 58-64 are axially aligned with and captured within groove 44. The relatively steep incline of beveled surface 50 insures that a proximal removal of pin connector 28 requires a substantially greater axial force as compared to connector insertion. The steep incline of beveled surface 48 likewise resists distal insertion of pin connector 28 beyond the desired axial alignment.

Accordingly, the mechanical coupling does not depend upon a frictional engagement of the nodules or indentations against the groove surface. There is no need for an elastic restoring force to maintain the nodules against the groove surface. In fact, in the preferred mechanical coupling, the distance "a" between indentations is approximately equal to the groove diameter "e", so that pin connector 28, when mechanically coupled within socket connector 24, remains free to rotate relative to the socket about connector axes 30 and 56. Consequently, exchange section 20 is maintained axially relative to guide section 18 when coupled, yet is free to rotate relative to the guide section. This arrangement prevents any substantial transfer of torque from the exchange section to the guide section, and thus substantially eliminates the chance for twisting, kinking, and other damage to the wires forming the guide and

exchange sections. This advantage is increasingly critical for wire sections having small diameters, i.e. at or approaching 0.010 inch (0.025 cm).

As previously mentioned, the mechanical coupling of connectors 24 and 28 is releasable. More particularly, exchange section 20 is pulled proximally relative to the guide section, whereby inclined surface 50 of the groove acts as a cam to deform the socket connector and thereby move the indentations radially outward and apart from one another. While the required axial force for disconnecting the extension section is greater than the insertion force in joining the sections, disconnection nonetheless is conveniently accomplished manually, with one hand gripping each of the extension and guide sections. Regardless of whether pin connector 28 is being inserted or removed, the requisite deformation of socket connector 24 is elastic, which allows for repeated connections and disconnections as required during the medical procedure, without reducing the efficacy of the mechanical coupling.

The use of guidewire 16 can be considered in connection with an angioplasty procedure to treat a blood vessel occlusion, formed for example due to an accumulation of plaque. This exemplary procedure involves two dilatation steps, followed by placement of a prosthesis.

The procedure is initiated by percutaneous and intravascular insertion of guide section 18, to a point where distal tip 22 is aligned with the occlusion site. At this stage, guide section 18 is free of exchange section 20. Nonetheless, guide section 18 is sufficiently long (e.g. 150 centimeters) such that with distal tip 22 so aligned, a proximal portion of the guide section including socket connector 24 remains outside of the patient.

Next, an initial dilatation catheter (not shown) is inserted, by placing its distal end over proximal end 52 of guide section 18. A lumen in the dilatation catheter accepts the guide section. The dilatation catheter is progressively advanced until a balloon at the distal end of a dilatation catheter is aligned with the occlusion. With guide section 18 in place, the dilatation catheter is positively directed toward the treatment site, and thus can be inserted relatively quickly without requiring undue attention. A proximal portion of the dilatation catheter remains outside of the patient, and the proximal portion of the guide section extends at least a slight distance proximally of the dilatation catheter. At this stage, the dilatation balloon is expanded to enlarge the vessel at the treatment site.

After the initial expansion of the vessel at the occlusion, the dilatation catheter is withdrawn. The conventional procedure involved removing a guidewire and inserting a much longer exchange wire. In accordance with the present invention, guide section 18 remains in place, while exchange section 20 is coupled to the guide section by inserting pin connector 28 into socket connector 24, while holding the socket connector in place to maintain the axial position of guide section 18. A simple and direct axial (distal) pushing of the pin con-

ector is all that is required. The socket connector is elastically deformed temporarily, then rapidly returns to its normal configuration as groove 44 becomes aligned with indentations 53-64. This return of the socket connector brings the indentations against groove surface 46, providing a "snap fit" sensation that positively informs the physician with a tactile sensation of a successful coupling.

Several advantages arise from the fact that socket connector 24, when coupled, is in a relaxed state, rather than elastically deformed. First, there is no risk that gradually diminishing elastic restoring force might degrade the connection. Secondly, no torque is transferred through the interconnection. Accordingly, exchange section 20 can be rotated (whether intentionally or inadvertently) without rotating the proximal end of the guide section. Thus the exchange section can be manipulated as necessary, without the risk of twisting or kinking along the guide section.

Returning to the procedure, the coupling of guide section 18 and exchange section 20 substantially increases the length of wire outside of the patient (e.g. by another 150 centimeters). Exchange section 20 can be gripped by hand to maintain the axial position of guide section 18 while the initial dilatation catheter is proximally withdrawn.

After withdrawal, the guide and exchange sections remain coupled, as a second dilatation catheter (not shown) is inserted. More particularly, the second dilatation catheter has a lumen that accepts proximal end 26 of exchange section 20, enabling progressive advancement of the dilatation catheter along the guidewire until the second (perhaps larger) dilatation balloon is aligned at the treatment site. At this stage, connectors 24 and 28 are proximal of the second dilatation catheter, and it is advantageous to disconnect and remove the exchange section. Disconnection is accomplished easily by hand, holding socket connector 24 in place while proximally pulling the exchange section near pin connector 28. Disconnection requires temporary elastic deformation of socket connector 24. Disconnection is easily accomplished by hand. With the exchange section removed, there is no need for an attendant to handle an unwieldy length of exchange wire, and the physician can concentrate on the angioplasty procedure at hand, without distraction due to the exchange wire, as the second dilatation balloon is expanded against the occlusion.

After the second dilatation step, exchange section 20 is again coupled to guide section 18 as described above, and the second dilatation catheter is withdrawn over the guide and exchange sections. With the sections remaining coupled, a prosthesis delivery catheter is inserted over the proximal end of the exchange section, and advanced progressively until a prosthesis (e.g. a radially self-expanding stent) at the distal end of the catheter is aligned at the treatment site. At this point the exchange section is disconnected and removed, leaving just the proximal portion of the guide section exposed

beyond the prosthesis delivery catheter. The physician can concentrate on prosthesis deployment and delivery, free of concern about exchange section 20.

Following prosthesis deployment, guide section 18 and the deployment catheter are withdrawn. Alternatively, should any further catheters be required (e.g. an endoscopic catheter to view stent placement), the guide and exchange sections are coupled once again to enable withdrawal of the delivery catheter while guide section 18 remains in place. In either event, repeated connections and disconnections of the guide and exchange sections do not structurally alter either connector, or in any other manner degrade the quality of the mechanical coupling.

Figure 10 shows a socket connector 72 utilized in an alternative guidewire system, in which the exchange section is similar to exchange section 20. Three indentations 74, 76 and 78 are formed in the annular wall of socket 72 at its medial region, with the indentations spaced apart from one another angularly by about 120°. Insertion of the exchange section into socket 72 forces indentations 74-78 radially outward away from one another, much in the manner as described above in connection with socket connector 24. Again, mechanical coupling involves an axial alignment of the indentations with a groove in the tip connector, with the indentations captured within the groove.

Figures 11-15 illustrate another highly preferred embodiment guidewire 80, including a guide section 82 and an exchange section 84, coupled relative to one another by a socket connector 86. More particularly, a pin connector 88 at the proximal end of the guide section, and a pin connector 90 at the distal end of the exchange section, are inserted into socket connector 86, to be retained within the socket connector as shown in broken lines.

Figure 12 shows pin connector 90 in greater detail. A truncated conical region 92 converges distally from the nominal diameter of the exchange section to a shank 94 of the pin connector. An annular recess or groove 96 is formed in the pin connector, near a cylindrical head 98 that forms the distal end of the pin connector. A steeply inclined groove surface 100 is disposed between the groove and the head. Between the groove and shank 94 is a more gradually inclined groove surface 102.

Pin connector 88 of the guide section is substantially identical to pin connector 90.

Socket connector 86 is shown in greater detail in Figures 13 and 14. The socket includes an annular wall 103 with opposite proximal and distal ends 104 and 106 for insertion of pin connectors 90 and 88, respectively. Connector wall 103 is selectively cut and crimped to form a proximal indentation 108 and a distal indentation 110, facing in opposite directions but otherwise substantially identical to one another. In each case, a transverse slit through connector wall 103 permits a controlled bending or crimping of a selected area of connector wall 103 on one side of the slit.

As seen in connection with proximal indentation 108 (Figure 14), the result of this selective reshaping is a gradually inclined wall portion 112 having an arcuate lateral profile terminating in a relatively steep distal edge 114. Wall portion 112 is visible in Figure 14 through an opening 115 between edge 114 and connector wall 103, which opening is formed as a result of the slit and selective reshaping.

Distal indentation 110 is substantially identical to indentation 108, having a gradually inclined wall portion 116 that terminates at a steeply inclined edge 118 (Figure 13).

Figure 15 schematically represents the insertion of pin connector 90 into socket connector 86. The diameter of head 98, indicated at "c", is less than the inside diameter "b" of the socket connector, but exceeds the distance "a" between proximal indentation 108 and the opposite side of wall 103. Thus, as pin connector 90 is moved rightward as viewed in the figure, head 98 eventually contacts wall portion 112 of indentation 108. Upon further rightward movement of the pin connector, head 90 elastically deforms socket connector 86, particularly in the region of indentation 108. As head 98 moves rightward along gradually inclined surface 112, the socket connector is deformed a sufficient amount to permit passage of the head rightward beyond indentation 108, to align the indentation with groove 96. The gradual incline of wall portion 112 facilitates insertion of pin connector 90, much in the same manner that previously discussed cone surface 38 promotes insertion of pin connector 28.

Once head 98 is beyond indentation 108, socket connector 86 elastically recovers, i.e. returns to the shape of its relaxed condition, wherein the indentation and opposite portion of connector wall 103 are once again separated by the distance "a". Elastic recovery is relatively rapid, due to the steep incline of groove surface 100 and the elastic restoring force in the socket connector. Thus, as before, elastic recovery provides a tactile sensation that a mechanical coupling has been achieved. The relatively steep incline of groove surface 100, and the relatively steep incline of edge 114, insure that a proximal removal of pin connector 90 requires substantially greater axial force than connector insertion.

Preferably, the distance "a" slightly exceeds the diameter "d" of groove 96, so that when mechanically coupled, pin connector 90 and socket connector 86 nonetheless remain free to rotate relative to one another, thus to allow exchange section 84 to rotate relative to guide section 82 while being maintained axially relative to the guide section. As previously noted, this feature prevents any substantial transfer of torque from the exchange section to the guide section.

Pin connector 90 includes a gradually inclined groove surface 102 proximally of groove 96, as opposed to the relatively steep surface 48 of pin connector 28. Surface 102 is not relied upon to limit the distal movement of pin connector 90 relative to socket connector

86. Rather, such distal movement is limited by conical region 82 of pin connector, as this surface encounters proximal end 104 of the socket connector.

Insertion of pin connector 88 into socket connector 86 is accomplished in much the same manner as insertion of pin connector 90, except that pin connector 88 is inserted into distal end 106 and moved in the proximal direction to the point of mechanical connection.

Thus, proximal indentation 108 and distal indentation 110 capture head 98 and a head 120 of pin connector 88, respectively, which maintains the mechanical coupling of the pin connectors within socket connector 86. Further, however, it is preferred to permanently bond the socket connector to pin connector 88 and guide section 82. This is accomplished by joining an inclined surface 122 of connector 88 to a similarly inclined surface at distal end 106 of the socket connector, after applying a suitable medical adhesive to one or both of these surfaces.

20 Socket connector 86 and pin connectors 88/90 afford several advantages over socket connector 24 and pin connector 28. Indentations 108/110, as compared to nodules 58-64, are easier to form, and can be formed with more consistency (tighter dimensional tolerances) over numerous repetitions. More importantly, however, is that indentations 108/110 can be formed asymmetrically, to provide the gradual wall portion in combination with the steep edge. The result, as noted above, is to facilitate insertion of the pin connectors while providing substantially increased resistance to their withdrawal, without the need for special shaping of the connector tip, e.g. as in providing conical head 32 of pin connector 28. The conical head is difficult to form, particularly for small diameter guidewires. Accordingly, elimination of the need to fabricate the cone is a substantial advantage.

Typical guidewires in accordance with the present invention can have diameters ranging from about .014" to .018" (0.036 cm to 0.046 cm) for coronary applications, and from about .018" to .063" (0.046 cm to 0.16 cm) for peripheral applications. In one preferred version of guidewire 80, the wire, pin connector and socket connector dimensions in inches are as follows:

#### 45 Pin Connectors:

Wire outside diameter: 0.014 (0.036 cm)

Shank outside diameter: 0.009 (0.023 cm)

Groove outside diameter: 0.007 (0.018 cm)

Head outside diameter: 0.009 (0.023 cm)

#### 50 Socket Connector:

Length: 0.75 (1.91 cm)

Nominal inside diameter: 0.010 (0.025 cm)

Distance between indentations and opposite side of socket: 1.00 (2.54 cm)

## Guidewire:

Outside diameter: 0.014 (0.036 cm)

Thus in accordance with the present invention, catheters can be exchanged repeatedly while a distal guide section remains in place for guiding each catheter to the treatment site. An exchange section is easily and quickly connected to the guide section to provide an extended proximal region of the guidewire when needed for catheter insertion or withdrawal. When no longer needed, the exchange section is easily disconnected. Because each connection and disconnection requires only a temporary elastic deformation of the connector structure, repeated connections and disconnections do not degrade the quality of the coupling. There is no substantial elastic load during coupling, further insuring against degradation and preventing the transfer of torque from the exchange section to the guide section. Finally, the manner in which the nodules of one of the connectors are captured into a groove of the other connector, provides a tactile sensation to signal the physician of a successful coupling.

## Claims

1. An interconnection apparatus for body insertable guidewires and exchange wires, including:

a first connector (28) at one end of a first wire, said first connector (28) being substantially symmetrical about a first connector axis and having a first end region (32) and a recessed region (40) adjacent the first end region (32); and

a second connector (24) adapted for mounting at one end of a second wire, said second connector (24) having a second connector axis and a projection means (58, 60, 62, 64);

wherein the first and second connectors (24, 28), when positioned in confronting and at least generally axially aligned relation, are movable axially toward one another into a mechanical coupling in which the projection means (58, 60, 62, 64) is aligned with and extends radially toward the recessed region (40); a selected one of the connectors (24, 28) elastically deforming to allow the first end region (32) to travel axially inward past the projection means (58, 60, 62, 64) as the connectors (24, 28) are moved toward said mechanical coupling and further at least substantially elastically recovering upon movement of the connectors (24, 28) into said mechanical coupling; the projection means (58, 60, 62, 64) and the first end region (32), with the connectors (24, 28) in said mechanical coupling, engaging one another to limit axial movement of the connectors (24, 28) away from one

another to maintain the mechanical coupling.

2. The apparatus of Claim 1 wherein:

5 the first and second connectors (24, 28) are rotatable relative to one another when in said mechanical coupling.

10 3. The apparatus of Claim 1 wherein:

15 said selected connector further is elastically deformable to allow axially outward passage of the projection means (58, 60, 62, 64) past the first end region (32) to facilitate a release of said mechanical coupling.

20 4. The apparatus of Claim 3 further including:

25 a stop means (42) for preventing any substantial axially inward movement of the first end region (32) relative to the second connector (24), when the connectors (24, 28) are in said mechanical coupling.

26 5. The apparatus of Claim 4 wherein:

30 the recessed region (40) comprises a groove (44) between the first end region (32) and a second and opposite end region of the first connector (28), said projection means (58, 60, 62, 64) extending radially into the groove (44) when the connectors (24, 28) are in said mechanical coupling.

35 6. The apparatus of Claim 5 wherein:

40 the stop means (42) comprises an inclined groove end surface between the groove (44) and the second end region.

45 7. The apparatus of Claim 4 wherein:

46 the stop means (42) comprises a truncated conical surface between the first connector (28) of the first wire and an end of the second connector (24), positioned to engage one another and thereby prevent further axially inward movement of the first connector (24) relative to the second connector (28).

50 8. The apparatus of Claim 1 wherein:

55 said first end region (32) of the first connector (24) is a truncated cone diverging in the axial direction toward the groove (44).

9. The apparatus of Claim 8 wherein:

56 said second end region (40) is a shank on the

opposite side of the groove (44) from the truncated cone (32), with an outside diameter of the shank (40) and a maximum outside diameter of the truncated cone (32) being greater than an outside diameter of the groove (44). 5

10. The apparatus of Claim 9 wherein: the outside diameter of the shank (40) and the maximum outside diameter of the truncated cone (32) are substantially equal. 10

11. The apparatus of Claim 9 wherein: said first connector (28), including the truncated cone (32), the groove (44) and the shank (40), is formed by selective removal of material from said one end of the first wire. 15

12. The apparatus of Claim 9 wherein: said truncated cone (32) diverges at an angle of about 20° with respect to first connector axis. 20

13. The apparatus of Claim 12 further including: two opposed groove end surfaces (48, 50) proximate the cone and the shank, respectively, said end surfaces being inclined at an angle of at least 45° relative to the first connector axis. 25

14. The apparatus of Claim 1 wherein: the second connector (24) comprises a socket having an annular wall, and the first connector (28) is inserted into the socket and surrounded by the socket when in said mechanical coupling. 30

15. The apparatus of Claim 14 wherein: the projection means (58, 60, 62, 64) comprises at least one indentation formed in the annular wall along a medial region of the socket. 35

16. The apparatus of Claim 15 wherein: the projection means (58, 60, 62, 64) comprises a plurality of indentations formed along the medial region and equally angularly spaced apart from one another. 40

17. The apparatus of Claim 16 wherein: the projection means (58, 60, 62, 64) comprises four of the indentations angularly spaced apart from one another 90° to provide two pairs 45

18. The apparatus of Claim 17 wherein: of opposed indentations at the medial region of the socket, wherein a distance between each pair of opposed indentations is less than a nominal interior diameter of the socket. 50

19. The apparatus of Claim 15 wherein: an outer diameter of the first end region (32) of the first connector (28) is less than the nominal interior diameter of the socket and greater than the distance between each pair of opposed indentations (58, 60, 62, 64), and wherein the socket is elastically deformable to permit insertion of the first connector (28) into the socket to carry the first end region (32) past the indentations (58, 60, 62, 64), to axially align the indentations (58, 60, 62, 64) and the groove (44). 55

20. The apparatus of Claim 19 wherein: an outer diameter of the second end region of the first connector (28) is less than the nominal interior diameter of the socket and exceeds the distance between each pair of opposed indentations (58, 60, 62, 64). 60

21. The apparatus of Claim 5 wherein: the first end region (32) comprises a head, the second end region comprises a shank (40), and said groove (44) has a diameter less than an outer diameter of the shank (40) and less than an outer diameter of the head (32). 65

22. The apparatus of Claim 1 wherein: the second connector (24) comprises a socket having an annular wall, the first connector (28) is inserted into the socket and surrounded by the socket when in said mechanical coupling, and the projection means (58, 60, 62, 64) comprises an indentation formed in the annular wall. 70

23. The apparatus of Claim 22 wherein: said indentation (58, 60, 62, 64) includes a gradually inclined wall portion that terminates in a steeply inclined edge, and wherein said first end region, when traveling axially inward 75

toward the indentation (58, 60, 62, 64), encounters the wall portion before encountering the edge.

24. A device for guiding and exchanging body insertable catheters, including:

a body insertable guide section formed of a flexible wire;

an exchange section formed of a flexible wire;

and an interconnection apparatus according to claim 1.

25. The device of Claim 24 wherein:

said at least one connector further is elastically deformable to allow axially outward passage of the projection means (58, 60, 62, 64) past the first end region (32) to release the mechanical coupling.

26. The device of Claim 25 wherein:

the first end region (32) of the first connector (28) is a truncated cone converging in the axial direction toward the groove (44), and the first connector (28) further includes a second end region comprising a shank (40) on the opposite side of the recessed region from the truncated cone (32).

27. The device of Claim 26 wherein:

an outside diameter of the shank (40) and a maximum outside diameter of a truncated cone (32) are approximately equal to one another and are greater than an outside diameter of the recessed region (44).

28. The apparatus of Claim 25 wherein:

the first end region (32) of the first connector (28) comprises a cylindrical head.

29. The apparatus of Claim 26 wherein:

the second connector (24) comprises a socket having an annular wall, and the first connector (28) is inserted into the socket and surrounded by the socket when in the mechanical coupling.

30. The device of Claim 29 wherein:

the socket has a nominal inside diameter, and the projection means (58, 60, 62, 64) comprises at least one indentation formed in the annular wall.

31. The device of Claim 30 wherein:

said at least one indentation includes a gradually inclined wall portion having an axially inward and steeply inclined edge.

32. The device of Claim 29 wherein:

the projection means (58, 60, 62, 64) comprises four indentations formed in the annular wall along the medial region and spaced apart angularly 90° from one another to provide two pairs of opposed indentations at the medial region, wherein a distance between each pair of opposed indentations is less than the nominal inside diameter.

33. The device of Claim 32 wherein:

respective outside diameters of the first end region (32) and the second end region of the first connector (28), are less than the nominal inside diameter of the socket and greater than the distance between each pair of indentations (58, 60, 62, 64).

34. The device of Claim 33 wherein:

the distance between each pair of opposed indentations (58, 60, 62, 64) is at least equal to an outside diameter of the groove (44).

35. The device of Claim 32 wherein:

the first end region (32) of the first connector (28) comprises a truncated cone diverging in the direction toward the groove (44), and the second end region of the connector comprises a shank (40) on the opposite side of the groove (44) from the cone (32) and having an outside diameter substantially equal to a maximum outside diameter of the truncated cone (32).

36. The device of Claim 27 wherein:

the guide section (18) includes a proximal extension (68), and a distal end portion of the socket surrounds the proximal extension (68).

37. The device of Claim 36 wherein:

the guide section (18) further includes an annular beveled transition surface (70) between the proximal extension (68) and the remainder of the guide section, and the socket has an annular beveled distal surface (66) parallel to the transition surface (70).

38. An interconnection apparatus for body insertable guidewires and exchange wires, including:

a first connector (90) at one end of a first wire and having a first end region (98) and a first recessed region (96) adjacent the first end region (98);

a second connector (88) at one end of a second wire and having a second end region (120) and a second recessed region (96) adjacent the second end region (120);

an elongate third connector (86) having first and second opposite ends for receiving the first and second connectors (90, 88), respectively, and further having a first projection means (112) between the first and second ends;

wherein the first and second connectors (90), when positioned in confronting relation to the third connector (86) at the first and second ends, respectively, are movable axially toward one another and relative to the third connector (86) into a mechanical coupling in which the first projection means (112) is aligned with and projects radially toward the first recessed region (96), a selected one of the first and third connectors (86, 90) elastically deforming to allow the first end region (98) to travel axially inward past the projection means (112) as the connectors (86, 90) are moved toward said mechanical coupling and further at least substantially elastically recovering upon achievement of said mechanical coupling, whereupon the first end region (98) and the first projection means (112) are positioned to engage one another to limit axial movement of the first connector (90) and third connector (86) away from one another to maintain the mechanical coupling; and

a means for joining the second and third connectors (86, 90) to one another.

39. The apparatus of Claim 38 wherein:

said means for joining the second and third connectors (86, 90) to each other comprise an adhesive for bonding said second end of the third connector (86) to the second connector (90).

40. The apparatus of Claim 38 wherein:

said means for joining the second and third connectors (86, 90) comprises a second projection (116) means in the third connector (86) and axially spaced apart from the first projection means (112) and, upon insertion of the second connector (88) a sufficient distance to move the second end region (120) beyond the second projection means (116), positioned to engage the second end region (98) to limit axial movement of the second connector (90) and third connector (86) axially away from one

another.

41. The apparatus of Claim 40 wherein:

the first and second projection means (112, 116) respectively comprise first and second indentations, each indentation including a gradually inclined wall portion terminating in a steeply inclined edge, and wherein each of the first and second connectors (90), when being inserted into the third connector (86) toward its associated indentations, encounters the gradually inclined wall portion before encountering the steeply inclined edge.

#### Patentansprüche

1. Verbindungseinrichtung für in Körper einführbare Führungsdrähte und Austauschdrähte, umfassend:

einen ersten Verbinder (28) an einem Ende eines ersten Drahtes, wobei der besagte erste Verbinder (28) im wesentlichen symmetrisch zu einer ersten Verbinderachse ist und einen ersten Endbereich (32) und einen ausgesparten Bereich (40) angrenzend an den ersten Endbereich (32) aufweist; und

einen zum Anbringen an einem Ende eines zweiten Drahtes angepaßten zweiten Verbinder (24), wobei der besagte zweite Verbinder (24) eine zweite Verbinderachse und eine Vorsprungeinrichtung (58, 60, 62, 64) aufweist;

bei welcher der erste und zweite Verbinder (24, 28), wenn sie in gegenüberliegenden und mindestens allgemein axial ausgerichteter Beziehung angeordnet sind, in axialer Richtung aufeinander zu in eine mechanische Verbindung bewegbar sind, in welcher die Vorsprungeinrichtung (58, 60, 62, 64) mit dem ausgesparten Bereich (40) ausgerichtet ist und sich in radialer Richtung auf diesen zu erstreckt; wobei sich ein ausgewählter der Verbinder (24, 28) elastisch verformt, um es dem ersten Endbereich (32) zu gestalten, sich an der Vorsprungeinrichtung (58, 60, 62, 64) vorbei in axialer Richtung nach innen zu bewegen, wenn die Verbinder (24, 28) auf die besagte mechanische Verbindung zu bewegt werden, und sich weiter nach einer Bewegung der Verbinder (24, 28) in die besagte mechanische Verbindung mindestens im wesentlichen elastisch erholt; wobei die Vorsprungeinrichtung (58, 60, 62, 64) und der erste Endbereich (32), wenn sich die Verbinder (24, 28) in der besagten mechanischen Verbindung befinden, miteinander in Eingriff treten, um eine axiale Bewegung der Verbinder (24, 28) weg voneinander zu begrenzen, um die mechanische Verbindung aufrechtzuerhalten.

## 2. Einrichtung nach Anspruch 1, bei welcher:

der erste und zweite Verbinder (24, 28) in Bezug zueinander drehbar sind, wenn sie sich in der besagten mechanischen Verbindung befinden.

## 3. Einrichtung nach Anspruch 1, bei welcher:

der besagte ausgewählte Verbinder weiter elastisch verformbar ist, um einen Vorbeitritt der Vorsprungeeinrichtung (58, 60, 62, 64) am ersten Endbereich (32) in axialer Richtung nach außen zu gestatten, um ein Lösen der besagten mechanischen Verbindung zu erleichtern.

## 4. Einrichtung nach Anspruch 3, weiter umfassend:

eine Anschlageinrichtung (42), um jegliche wesentliche Bewegung des ersten Endbereichs (32) in Bezug zum zweiten Verbinder (24) in axialer Richtung nach innen zu verhindern, wenn sich die Verbinder (24, 28) in der besagten mechanischen Verbindung befinden.

## 5. Einrichtung nach Anspruch 4, bei welcher:

der ausgesparte Bereich (40) eine Nut (44) zwischen dem ersten Endbereich (32) und einem zweiten und entgegengesetzten Endbereich des ersten Verbinder (28) umfaßt, wobei sich die besagte Vorsprungeinrichtung (58, 60, 62, 64) in radialer Richtung in die Nut (44) erstreckt, wenn sich die Verbinder (24, 28) in der besagten mechanischen Verbindung befinden.

## 6. Einrichtung nach Anspruch 5, bei welcher:

die Anschlageinrichtung (42) eine schräge Nutstirnfläche zwischen der Nut (44) und dem zweiten Endbereich umfaßt.

## 7. Einrichtung nach Anspruch 4, bei welcher:

die Anschlageinrichtung (42) eine kegelstumpfförmige Oberfläche zwischen dem ersten Verbinder (28) des ersten Drahtes und einem Ende des zweiten Verbinder (24) umfaßt, die so angeordnet sind, daß sie miteinander in Eingriff treten und dadurch eine weitere Bewegung des ersten Verbinder (24) in Bezug zum zweiten Verbinder (28) in axialer Richtung nach innen verhindern.

## 8. Einrichtung nach Anspruch 1, bei welcher:

der besagte erste Endbereich (32) des ersten

Verbinder (24) ein Kegelstumpf ist, der in axialer Richtung auf die Nut (44) zu divergiert.

## 9. Einrichtung nach Anspruch 8, bei welcher:

der besagte zweite Endbereich (40) ein Schaft auf der dem Kegelstumpf (32) entgegengesetzten Seite der Nut (44) ist, wobei ein Außendurchmesser des Schaftes (40) und ein maximaler Außendurchmesser des Kegelstumpfs (32) größer als ein Außendurchmesser der Nut (44) sind.

## 10. Einrichtung nach Anspruch 9, bei welcher:

der Außendurchmesser des Schaftes (40) und der maximale Außendurchmesser des Kegelstumpfs (32) im wesentlichen gleich sind.

## 11. Einrichtung nach Anspruch 9, bei welcher:

der besagte erste Verbinder (28), welcher den Kegelstumpf (32), die Nut (44) und den Schaft (40) enthält, durch selektives Entfernen von Material von dem besagten einen Ende des ersten Drahtes geformt wird.

## 12. Einrichtung nach Anspruch 9, bei welcher:

der besagte Kegelstumpf (32) unter einem Winkel von etwa 20° in Bezug zur ersten Verbinderachse divergiert.

## 13. Einrichtung nach Anspruch 12, weiter umfassend:

zwei entgegengesetzte Nutstirnflächen (48, 50) in der Nähe des Kegels bzw. des Schaftes, wobei die besagten Stirnflächen in Bezug zur ersten Verbinderachse unter einem Winkel von mindestens 45° geneigt sind.

## 14. Einrichtung nach Anspruch 1, bei welcher:

der zweite Verbinder (24) eine Buchse mit einer ringförmigen Wand umfaßt, und der erste Verbinder (28) in die Buchse eingeführt und von der Buchse umgeben ist, wenn sie sich in der besagten mechanischen Verbindung befinden.

## 15. Einrichtung nach Anspruch 14, bei welcher:

die Vorsprungeinrichtung (58, 60, 62, 64) mindestens eine entlang eines medialen Bereichs der Buchse in der ringförmigen Wand ausgebildete Eindrückung umfaßt.

## 16. Einrichtung nach Anspruch 15, bei welcher:

die Vorsprungeinrichtung (58, 60, 62, 64) eine Mehrzahl von Eindrückungen umfaßt, die entlang des medialen Bereichs ausgebildet und in gleichen Winkelabständen voneinander angeordnet sind.

17. Einrichtung nach Anspruch 16, bei welcher:

die Vorsprungeinrichtung (58, 60, 62, 64) vier der Eindrückungen umfaßt, die in Winkelabständen von 90° voneinander angeordnet sind, um am medialen Bereich der Buchse zwei Paare von einander gegenüberliegenden Eindrückungen bereitzustellen, wobei ein Abstand zwischen jedem Paar von einander gegenüberliegenden Eindrückungen kleiner als ein Nenninnendurchmesser der Buchse ist.

18. Einrichtung nach Anspruch 17, bei welcher:

ein Außendurchmesser des ersten Endbereichs (32) des ersten Verbinders (28) kleiner als der Nenninnendurchmesser der Buchse und größer als der Abstand zwischen jedem Paar von einander gegenüberliegenden Eindrückungen (58, 60, 62, 64) ist, und bei welcher die Buchse elastisch verformbar ist, um ein Einführen des ersten Verbinders (28) in die Buchse zu gestatten, um den ersten Endbereich (32) an den Eindrückungen (58, 60, 62, 64) vorbei mitzuführen, um die Eindrückungen (58, 60, 62, 64) und die Nut (44) in axialer Richtung auszurichten.

19. Einrichtung nach Anspruch 15, bei welcher:

ein Außendurchmesser des zweiten Endbereichs des ersten Verbinders (28) kleiner als der Nenninnendurchmesser der Buchse ist und den Abstand zwischen jedem Paar von einander gegenüberliegenden Eindrückungen (58, 60, 62, 64) übersteigt.

20. Einrichtung nach Anspruch 19, bei welcher:

der Abstand zwischen jedem Paar von einander gegenüberliegenden Eindrückungen (58, 60, 62, 64) mindestens gleich einem Außendurchmesser der Nut (44) ist, wodurch sich der erste Verinder (28) in Bezug zur Buchse frei um die erste Verbinderachse drehen kann, wenn sie sich in der mechanischen Verbindung befinden.

21. Einrichtung nach Anspruch 5, bei welcher:

der erste Endbereich (32) einen Kopf umfaßt, der zweite Endbereich einen Schaft (40) umfaßt, und die besagte Nut (44) einen Durch-

10 22. Einrichtung nach Anspruch 1, bei welcher:

der zweite Verinder (24) eine Buchse mit einer ringförmigen Wand umfaßt, der erste Verinder (28) in die Buchse eingeführt und von der Buchse umgeben ist, wenn sie sich in der besagten mechanischen Verbindung befinden, und die Vorsprungeinrichtung (58, 60, 62, 64) eine in der ringförmigen Wand ausgebildete Eindrückung umfaßt.

15 23. Einrichtung nach Anspruch 22, bei welcher:

die besagte Eindrückung (58, 60, 62, 64) einen Wandteil mit einer allmählichen Steigung einschließt, der in einer Kante mit einer steilen Steigung endet, und bei welcher der besagte erste Endbereich, wenn er sich in axialer Richtung auf die Eindrückung (58, 60, 62, 64) zu nach innen bewegt, auf den Wandteil trifft, bevor er auf die Kante trifft.

20 24. Vorrichtung zum Führen und Austauschen von in Körper einführbaren Kathetern, umfassend:

einen aus einem biegsamen Draht ausgebildeten, in Körper einführbaren Führungsabschnitt; einen aus einem biegsamen Draht ausgebildeten Austauschabschnitt; und eine Verbindungseinrichtung nach Anspruch 1.

25 25. Vorrichtung nach Anspruch 24, bei welcher:

der besagte mindestens eine Verinder weiter elastisch verformbar ist, um einen Vorbeitritt der Vorsprungeinrichtung (58, 60, 62, 64) am ersten Endbereich (32) in axialer Richtung nach außen zu gestatten, um die mechanische Verbindung zu lösen.

30 40 26. Vorrichtung nach Anspruch 25, bei welcher:

der erste Endbereich (32) des ersten Verbinders (28) ein Kegelstumpf ist, der in axialer Richtung auf die Nut (44) zu konvergiert, und der erste Verinder (28) weiter einen zweiten Endbereich einschließt, welcher einen Schaft (40) auf der dem Kegelstumpf (32) entgegengesetzten Seite des ausgesparten Bereichs umfaßt.

45 50 27. Vorrichtung nach Anspruch 26, bei welcher:

ein Außendurchmesser des Schaftes (40) und ein maximaler Außendurchmesser eines

Kegelstumps (32) ungefähr gleich und größer als ein Außendurchmesser des ausgesparten Bereichs (44) sind.

28. Vorrichtung nach Anspruch 25, bei welcher: 5  
der erste Endbereich (32) des ersten Verbinders (28) einen zylindrischen Kopf umfaßt.

29. Vorrichtung nach Anspruch 26, bei welcher: 10  
der zweite Verbinde (24) eine Buchse mit einer ringförmigen Wand umfaßt, und der erste Verbinde (28) in die Buchse eingebracht und von der Buchse umgeben ist, wenn sie sich in 15 der mechanischen Verbindung befinden.

30. Vorrichtung nach Anspruch 29, bei welcher: 20  
die Buchse einen Nennniederdurchmesser aufweist, und die Vorsprungeinrichtung (58, 60, 62, 64) mindestens eine in der ringförmigen Wand ausgebildete Eindrückung umfaßt.

31. Vorrichtung nach Anspruch 30, bei welcher: 25  
die besagte mindestens eine Eindrückung einen Wandteil mit einer allmählichen Steigung einschließt, der eine in axialer Richtung nach innen zu angeordnete Kante mit einer steilen 30 Steigung aufweist.

32. Vorrichtung nach Anspruch 29, bei welcher: 35  
die Vorsprungeinrichtung (58, 60, 62, 64) vier Eindrückungen umfaßt, die entlang des medialen Bereichs in der ringförmigen Wand ausgebildet und in Winkelabständen von 90° voneinander angeordnet sind, um am medialen Bereich zwei Paare von einander gegenüberliegenden Eindrückungen bereitzustellen, wobei ein Abstand zwischen jedem Paar von 40 einander gegenüberliegenden Eindrückungen kleiner als der Nennniederdurchmesser ist.

33. Vorrichtung nach Anspruch 32, bei welcher: 45  
jeweilige Außendurchmesser des ersten Endbereichs (32) und des zweiten Endbereichs des ersten Verbinders (28) kleiner als der Nennniederdurchmesser der Buchse und größer als der Abstand zwischen jedem Paar von Eindrückungen (58, 60, 62, 64) ist.

34. Vorrichtung nach Anspruch 33, bei welcher: 50  
der Abstand zwischen jedem Paar von einander gegenüberliegenden Eindrückungen (58, 60, 62, 64) mindestens gleich einem Außen-

durchmesser der Nut (44) ist.

35. Vorrichtung nach Anspruch 32, bei welcher: 55  
der erste Endbereich (32) des ersten Verbinders (28) einen Kegelstumpf umfaßt, der in Richtung auf die Nut (44) zu divergiert, und der zweite Endbereich des Verbinders einen Schaft (40) umfaßt, der auf der vom Kegel (32) aus entgegengesetzten Seite der Nut (44) angeordnet ist und einen Außendurchmesser aufweist, der einem maximalen Außendurchmesser des Kegelstumps (32) im wesentlichen gleich ist.

36. Vorrichtung nach Anspruch 27, bei welcher: 60  
der Führungsabschnitt (18) eine proximale Verlängerung (68) umfaßt, und ein distaler Endteil der Buchse die proximale Verlängerung (68) umgibt.

37. Vorrichtung nach Anspruch 36, bei welcher: 65  
der Führungsabschnitt (18) weiter eine ringförmige angeschrägte Übergangsfläche (70) zwischen der proximalen Verlängerung (68) und dem Rest des Führungsabschnitts umfaßt, und die Buchse eine zur Übergangsfläche (70) parallele ringförmige angeschrägte distale Oberfläche (66) aufweist.

38. Verbindungseinrichtung für in Körper einführbare Führungsdrähte und Austauschdrähte, umfassend: 70  
einen ersten Verbinde (90) an einem Ende eines ersten Drahtes und mit einem ersten Endbereich (98) und einem ersten ausgesparten Bereich (96) angrenzend an den ersten Endbereich (98);  
einen zweiten Verbinde (88) an einem Ende eines zweiten Drahtes und mit einem zweiten Endbereich (120) und einem zweiten ausgesparten Bereich (96) angrenzend an den zweiten Endbereich (120) aufweist;  
einen langgestreckten dritten Verbinde (86) mit einem jeweils entgegengesetzten ersten und zweiten Ende zur Aufnahme des ersten bzw. zweiten Verbinders (90, 88), und weiter mit einer ersten Vorsprungeinrichtung (112) zwischen dem ersten und zweiten Ende; bei welcher der erste und zweite Verbinde (90), wenn sie am ersten bzw. zweiten Ende in gegenüberliegender Beziehung zum dritten Verbinde (86) angeordnet sind, in axialer Richtung aufeinander zu und in Bezug zum dritten Verbinde (86) in eine mechanische Verbindung bewegbar sind, in welcher die erste Vorsprungeinrichtung (112) mit dem ersten

ausgesparten Bereich (96) ausgerichtet ist und in radialer Richtung auf diesen zu übersteht; wobei sich ein ausgewählter des ersten und dritten Verbinders (86, 90) elastisch verformt, um es dem ersten Endbereich (98) zu gestalten, sich an der Vorsprungeinrichtung (112) vorbei in axialer Richtung nach innen zu bewegen, wenn die Verbinders (86, 90) auf die besagte mechanische Verbindung zu bewegt werden, und sich nach Vollendung der besagten mechanischen Verbindung weiter mindestens im wesentlichen elastisch erhöht, woraufhin der erste Endbereich (98) und die erste Vorsprungeinrichtung (112) so angeordnet sind, daß sie miteinander im Eingriff stehen, um eine axiale Bewegung des ersten Verbinders (90) und des dritten Verbinders (86) weg voneinander zu begrenzen, um die mechanische Verbindung aufrechtzuerhalten; und eine Einrichtung zum gegenseitigen Zusammenfügen des zweiten und dritten Verbinders (86, 90).

39. Einrichtung nach Anspruch 38, bei welcher: die besagte Einrichtung zum gegenseitigen Zusammenfügen des zweiten und dritten Verbinders (86, 90) einen Kleber umfaßt, um das besagte zweite Ende des dritten Verbinders (86) mit dem zweiten Verbinde (90) zu verkleben.

40. Einrichtung nach Anspruch 38, bei welcher: die besagte Einrichtung zum Zusammenfügen des zweiten und dritten Verbinders (86, 90) eine zweite Vorsprungeinrichtung (116) im dritten Verbinde (86) umfaßt, die in axialer Richtung im Abstand von der ersten Vorsprungeinrichtung (112) und nach dem Einführen des zweiten Verbinders (88) in einem ausreichenden Abstand angeordnet ist, um den zweiten Endbereich (120) über die zweite Vorsprungeinrichtung (116) hinaus zu bewegen, welche so angeordnet ist, daß sie mit dem zweiten Endbereich (98) in Eingriff tritt, um eine axiale Bewegung des zweiten Verbinders (90) und des dritten Verbinders (86) in axialer Richtung weg voneinander zu begrenzen.

41. Vorrichtung nach Anspruch 40, bei welcher: die erste bzw. zweite Vorsprungeinrichtung (112, 116) eine erste bzw. zweite Eindrückung umfassen, wobei jede Eindrückung einen Wandteil mit einer allmählichen Steigung enthält, der in einer Kante mit einer steilen Steigung endet, und bei welcher sowohl der erste

und zweite Verbinde (90) beim Einführen in den dritten Verbinde (86) auf dessen zugehörige Eindrückungen zu auf den Wandteil mit der allmählichen Steigung trifft, bevor er auf die Kante mit der steilen Steigung trifft.

Revendications

1. Appareil d'interconnexion pour des fils de guidage et des fils de remplacement susceptibles d'être introduits dans le corps, comprenant :

un premier connecteur (28) à une extrémité d'un premier fil, ledit premier connecteur (28) étant sensiblement symétrique autour d'un premier axe de connecteur et comportant une première région d'extrémité (32) et une région en retrait (40) contiguë à la première région d'extrémité (32) ; et

un second connecteur (24) destiné à être assemblé à une première extrémité d'un second fil, ledit second connecteur (24) ayant un second axe de connecteur et des moyens formant prolongement (58, 60, 62, 64) ; dans lequel les premier et second connecteurs (24, 28), lorsqu'ils sont positionnés face à face et au moins généralement alignés axialement, sont mobiles axialement l'un vers l'autre dans un couplage mécanique dans lequel les moyens formant prolongement (58, 60, 62, 64) sont alignés avec la région en retrait (40) et s'étendent radialement vers celle-ci ; un connecteur sélectionné parmi les connecteurs (24, 28) se déformant de manière élastique pour permettre à la première région d'extrémité (32) de se déplacer axialement vers l'intérieur au-delà des moyens formant prolongement (58, 60, 62, 64) alors que les connecteurs (24, 28) sont déplacés vers ledit couplage mécanique et, de plus, retrouvant son état initial au moins sensiblement de manière élastique lors du mouvement des connecteurs (24, 28) dans ledit couplage mécanique ; les moyens formant prolongement (58, 60, 62, 64) et la première région d'extrémité (32), avec les connecteurs (24, 28) dans ledit couplage mécanique, se mettant en prise l'un avec l'autre pour limiter le mouvement axial des connecteurs (24, 28) éloignant l'un de l'autre pour maintenir le couplage mécanique.

2. Appareil selon la revendication 1, dans lequel : les premier et second connecteurs (24, 28) sont susceptibles de tourner l'un par rapport à l'autre lorsqu'ils se trouvent dans ledit couplage mécanique.

3. Appareil selon la revendication 1, dans lequel :

ledit connecteur sélectionné est, de plus, déformable de manière élastique pour permettre le passage axialement vers l'extérieur des moyens formant prolongement (58, 60, 62, 64) au-delà de la première région d'extrémité (32) pour faciliter une libération dudit couplage mécanique.

4. Appareil selon la revendication 3 comprenant, de plus :

des moyens d'arrêt (42) destinés à empêcher tout mouvement notable axialement vers l'intérieur de la première région d'extrémité (32) par rapport au second connecteur (24), lorsque les connecteurs (24, 28) se trouvent dans ledit couplage mécanique.

5. Appareil selon la revendication 4, dans lequel :

la région en retrait (40) comprend une gorge (44) entre la première région d'extrémité (32) et une seconde région d'extrémité opposée du premier connecteur (28), lesdits moyens formant prolongement (58, 60, 62, 64) s'étendant radialement dans la gorge (44) lorsque les connecteurs (24, 28) se trouvent dans ledit couplage mécanique.

6. Appareil selon la revendication 5, dans lequel :

les moyens d'arrêt (42) comprennent une surface d'extrémité de gorge inclinée entre la gorge (44) et la seconde région d'extrémité.

7. Appareil selon la revendication 4, dans lequel :

les moyens d'arrêt (42) comprennent une surface conique tronquée entre le premier connecteur (28) du premier fil et une extrémité du second connecteur (24), positionnés de manière à s'engager l'un dans l'autre et pour, de ce fait, empêcher un mouvement supplémentaire axialement vers l'intérieur du premier connecteur (24) par rapport au second connecteur (28).

8. Appareil selon la revendication 1, dans lequel :

ladite première région d'extrémité (32) du premier connecteur (24) est un cône tronqué divergeant dans la direction axiale vers la gorge (44).

9. Appareil selon la revendication 8, dans lequel :

ladite seconde région d'extrémité (40) est une tige sur le côté de la gorge (44) opposé au cône tronqué (32), avec un diamètre extérieur de la tige (40) et un diamètre extérieur maximal du cône tronqué (32) supérieurs à un diamètre extérieur de la gorge (44).

10. Appareil selon la revendication 9, dans lequel :

le diamètre extérieur de la tige (40) et le diamètre extérieur maximal du cône tronqué (32) sont sensiblement égaux.

11. Appareil selon la revendication 9, dans lequel :

ledit premier connecteur (28), comprenant le cône tronqué (32), la gorge (44) et la tige (40), est formé par l'enlèvement sélectif de matériau de ladite extrémité du premier fil.

12. Appareil selon la revendication 9, dans lequel :

ledit cône tronqué (32) diverge suivant un angle d'environ 20° par rapport au premier axe de connecteur.

13. Appareil selon la revendication 12 comprenant, de plus :

deux surfaces d'extrémité de gorge opposées (48, 50) à proximité du cône et de la tige, respectivement, lesdites surfaces d'extrémité étant inclinées d'un angle d'au moins 45° par rapport au premier axe de connecteur.

14. Appareil selon la revendication 1, dans lequel :

le second connecteur (24) comprend une fiche femelle comportant une paroi annulaire et le premier connecteur (28) est inséré dans la fiche femelle et entouré par la fiche femelle lorsqu'ils sont dans ledit couplage mécanique.

15. Appareil selon la revendication 14, dans lequel :

les moyens formant prolongement (58, 60, 62, 64) comprennent au moins une première indentation formée dans la paroi annulaire le long d'une région médiane de la fiche femelle.

16. Appareil selon la revendication 15, dans lequel :

les moyens formant prolongement (58, 60, 62, 64) comprennent une pluralité d'indentations formées le long de la région médiane et espacées d'un même angle les unes des autres.

17. Appareil selon la revendication 16, dans lequel :

les moyens formant prolongement (58, 60, 62, 64) comprennent quatre des indentations espacées les unes des autres d'un angle de

90° pour fournir deux paires d'indentations opposées dans la région médiane de la fiche femelle, dans lequel une distance entre chaque paire d'indentations opposées est inférieure à un diamètre intérieur nominal de la fiche femelle.

18. Appareil selon la revendication 17, dans lequel :

un diamètre extérieur de la première région d'extrémité (32) du premier connecteur (28) est inférieur au diamètre intérieur nominal de la fiche femelle et supérieur à la distance entre chaque paire d'indentations opposées (58, 60, 62, 64), et dans lequel la fiche femelle est déformable de manière élastique pour permettre l'insertion du premier connecteur (28) dans la fiche femelle pour transporter la première région d'extrémité (32) au-delà des indentations (58, 60, 62, 64), pour aligner axialement les indentations (58, 60, 62, 64) et la gorge (44).

19. Appareil selon la revendication 15, dans lequel :

un diamètre extérieur de la seconde région d'extrémité du premier connecteur (28) est inférieur au diamètre intérieur nominal de la fiche femelle et dépasse la distance entre chaque paire d'indentations opposées (58, 60, 62, 64).

20. Appareil selon la revendication 19, dans lequel :

la distance entre chaque paire d'indentations opposées (58, 60, 62, 64) est au moins égale à un diamètre extérieur de la gorge (44), de sorte que le premier connecteur (28), lorsqu'il se trouve dans le couplage mécanique, est libre de tourner par rapport à la fiche femelle autour du premier axe de connecteur.

21. Appareil selon la revendication 5, dans lequel :

la première région d'extrémité (32) comprend une tête, la seconde région d'extrémité comprend une tige (40) et ladite gorge (44) a un diamètre inférieur à un diamètre extérieur de la tige (40) et inférieur à un diamètre extérieur de la tête (32).

22. Appareil selon la revendication 1, dans lequel :

le second connecteur (24) comprend une fiche femelle comportant une paroi annulaire, le premier connecteur (28) est inséré dans la fiche femelle et entouré par la fiche femelle lorsqu'ils sont dans ledit couplage mécanique, et les moyens formant prolongement (58, 60, 62, 64)

compriment une indentation formée dans la paroi annulaire.

23. Appareil selon la revendication 22, dans lequel :

ladite indentation (58, 60, 62, 64) comprend une partie de paroi progressivement inclinée qui se termine en un bord fortement incliné, et dans lequel ladite première région d'extrémité, lorsqu'elle se déplace axialement vers l'intérieur vers l'indentation (58, 60, 62, 64), rencontre la partie de paroi avant de rencontrer le bord.

15 24. Dispositif pour guider et pour changer des cathéters susceptibles d'être introduits dans le corps, comprenant :

une section de guidage susceptible d'être introduite dans le corps constituée d'un fil flexible ;  
une section de remplacement constituée d'un fil flexible ; et  
un appareil d'interconnexion selon la revendication 1.

25. Dispositif selon la revendication 24, dans lequel :

ledit au moins un connecteur est, de plus, déformable de manière élastique pour permettre le passage axialement vers l'extérieur des moyens formant prolongement (58, 60, 62, 64) au-delà de la première région d'extrémité (32) pour libérer le couplage mécanique.

26. Dispositif selon la revendication 25, dans lequel :

la première région d'extrémité (32) du premier connecteur (28) est un cône tronqué convergant dans la direction axiale vers la gorge (44) et le premier connecteur (28) comprend, de plus, une seconde région d'extrémité comprenant une tige (40) sur le côté de la région en retrait opposé au cône tronqué (32).

27. Dispositif selon la revendication 26, dans lequel :

un diamètre extérieur de la tige (40) et un diamètre extérieur maximal d'un cône tronqué (32) sont à peu près égaux l'un à l'autre et sont supérieurs à un diamètre extérieur de la région en retrait (44).

28. Appareil selon la revendication 25, dans lequel :

la première région d'extrémité (32) du premier connecteur (28) comprend une tête cylindrique.

29. Appareil selon la revendication 26, dans lequel :  
 le second connecteur (24) comprend une fiche femelle comportant une paroi annulaire et le premier connecteur (28) est inséré dans la fiche femelle et entouré par la fiche femelle lorsqu'il se trouve en couplage mécanique. 5

30. Dispositif selon la revendication 29, dans lequel :  
 la fiche femelle a un diamètre intérieur nominal et les moyens formant prolongement (58, 60, 62, 64) comprennent au moins une première indentation formée dans la paroi annulaire. 10

31. Dispositif selon la revendication 30, dans lequel :  
 ladite au moins une indentation comprend une partie de paroi progressivement inclinée comportant un bord fortement incliné axialement vers l'intérieur. 15

32. Dispositif selon la revendication 29, dans lequel :  
 les moyens formant prolongement (58, 60, 62, 64) comprennent quatre indentations formées dans la paroi annulaire le long de la région médiane et séparées les unes des autres d'un angle de 90° pour fournir deux paires d'indentations opposées dans la région médiane, dans lequel une distance entre chaque paire d'indentations opposées est inférieure au diamètre intérieur nominal. 20

33. Dispositif selon la revendication 32, dans lequel :  
 les diamètres extérieurs respectifs de la première région d'extrémité (32) et de la seconde région d'extrémité du premier connecteur (28), sont inférieurs au diamètre intérieur nominal de la fiche femelle et supérieurs à la distance entre chaque paire d'indentations (58, 60, 62, 64). 25

34. Dispositif selon la revendication 33, dans lequel :  
 la distance entre chaque paire d'indentations opposées (58, 60, 62, 64) est au moins égale à un diamètre extérieur de la gorge (44). 30

35. Dispositif selon la revendication 32, dans lequel :  
 la première région d'extrémité (32) du premier connecteur (28) comprend un cône tronqué divergeant en direction de la gorge (44) et la seconde région d'extrémité du connecteur comprend une tige (40) sur le côté de la gorge (44) opposé au cône (32) et ayant un diamètre extérieur sensiblement égal à un diamètre 35

extérieur maximal du cône tronqué (32).

36. Dispositif selon la revendication 27, dans lequel :  
 la section de guidage (18) comprend un prolongement proximal (68) et une partie d'extrémité distale de la fiche femelle entoure le prolongement proximal (68). 40

37. Dispositif selon la revendication 36, dans lequel :  
 la section de guidage (18) comprend, de plus, une surface de transition annulaire en biseau (70) entre le prolongement proximal (68) et le reste de la section de guidage et la fiche femelle comporte une surface distale annulaire en biseau (66) parallèle à la surface de transition (70). 45

38. Appareil d'interconnexion pour des fils de guidage et des fils de remplacement susceptibles d'être introduits dans le corps, comprenant :  
 un premier connecteur (90) à une extrémité d'un premier fil et comportant une première région d'extrémité (98) et une première région en retrait (96) contiguë à la première région d'extrémité (98) ;  
 un second connecteur (88) à une extrémité d'un second fil et comportant une seconde région d'extrémité (120) et une seconde région en retrait (96) contiguë à la seconde région d'extrémité (120) ;  
 un troisième connecteur (86) allongé comportant des première et seconde extrémités opposées pour recevoir les premier et second connecteurs (90, 88), respectivement, et comportant, de plus, des premiers moyens formant prolongement (112) entre les première et seconde extrémités ;  
 dans lequel les premier et second connecteurs (90), lorsqu'ils sont positionnés face à face par rapport au troisième connecteur (86) aux première et seconde extrémités, respectivement, sont mobiles axialement l'un vers l'autre et par rapport au troisième connecteur (86) dans un couplage mécanique dans lequel les premiers moyens formant prolongement (112) sont alignés avec la première région en retrait (96) et s'étendent radialement vers celle-ci ; un connecteur sélectionné parmi les premier et troisième connecteurs (86, 90) se déformant de manière élastique pour permettre à la première région d'extrémité (98) de se déplacer axialement vers l'intérieur au-delà des moyens formant prolongement (112) au fur et à mesure que les connecteurs (86, 90) sont déplacés vers ledit couplage mécanique et, de plus, retrouvant leur état initial au moins sensi- 50

blement de manière élastique à l'accomplissement dudit couplage mécanique, ce sur quoi la première région d'extrémité (98) et les premiers moyens formant prolongement (112) sont positionnés de manière à s'engager l'un dans l'autre pour limiter l'écartement axial du premier connecteur (90) et du troisième connecteur (86) loin l'un de l'autre pour maintenir le couplage mécanique ; et  
des moyens destinés à unir les second et troisième connecteurs (86, 90) l'un à l'autre. 10

39. Appareil selon la revendication 38, dans lequel :

lesdits moyens destinés à unir les second et troisième connecteurs (86, 90) l'un à l'autre comprennent un adhésif pour fier ladite seconde extrémité du troisième connecteur (86) au second connecteur (90). 15

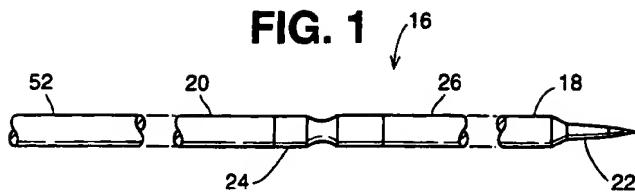
40. Appareil selon la revendication 38, dans lequel :

lesdits moyens destinés à unir les second et troisième connecteurs (86, 90) comprennent des seconds moyens formant prolongement (116) dans le troisième connecteur (86) et axialement séparés des premiers moyens formant prolongement (112) et, lors de l'insertion du second connecteur (86) d'une distance suffisante pour déplacer la seconde région d'extrémité (120) au-delà des seconds moyens formant prolongement (116), positionnés de manière s'engager dans la seconde région d'extrémité (98) pour limiter le mouvement axial du second connecteur (90) et du troisième connecteur (86) les écartant axialement. 20 25 30 35

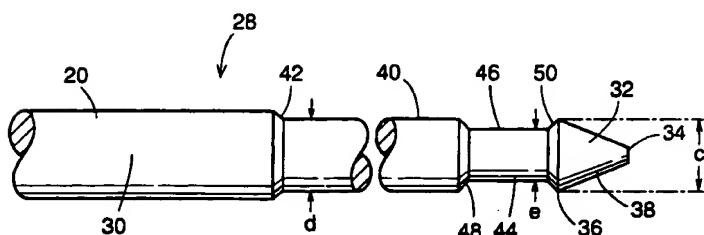
41. Appareil selon la revendication 40, dans lequel :

les premiers et seconds moyens formant prolongement (112, 116) comprennent, respectivement, des première et seconde indentations, chaque indentation comprenant une partie de paroi progressivement inclinée se terminant en un bord fortement incliné, et dans lequel chacun des premier et second connecteurs (90), lorsqu'ils sont insérés dans le troisième connecteur (86) vers ses indentations associées, rencontre la partie de paroi progressivement inclinée avant de rencontrer le bord fortement incliné. 40 45 50 55

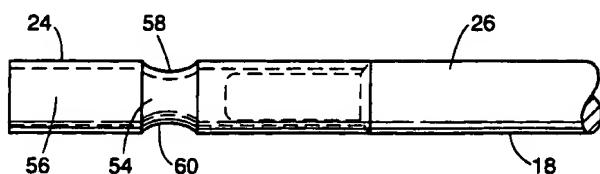
**FIG. 1**



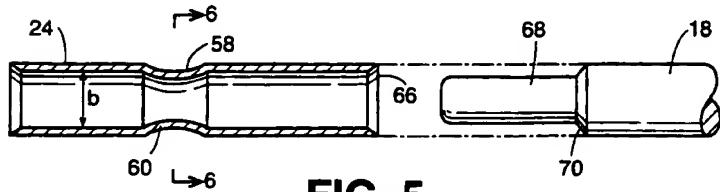
**FIG. 2**



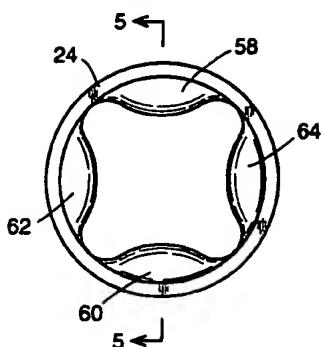
**FIG. 3**



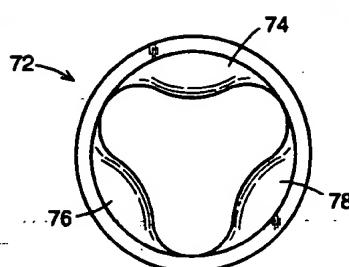
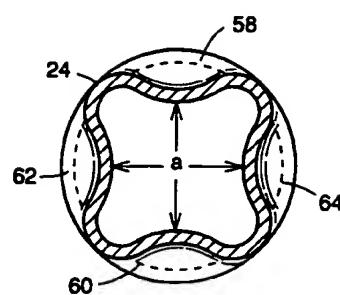
**FIG. 5**



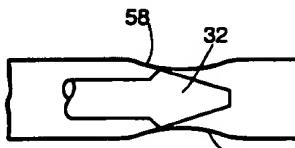
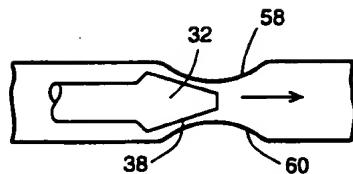
**FIG. 4**



**FIG. 6**

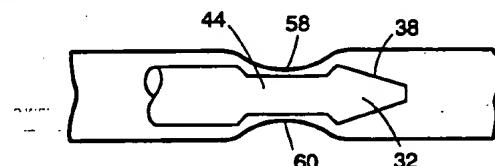


**FIG. 10**



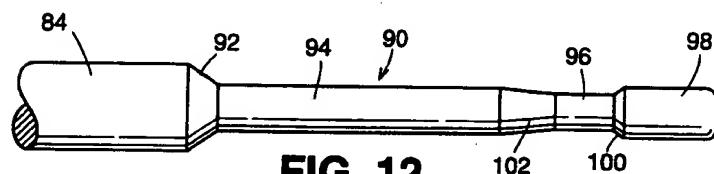
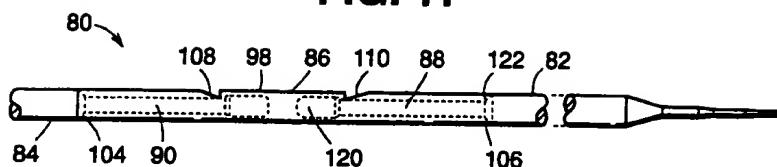
**FIG. 7**

**FIG. 8**

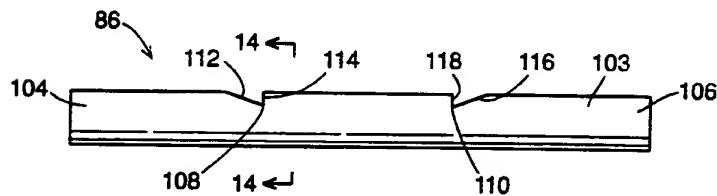


**FIG. 10**

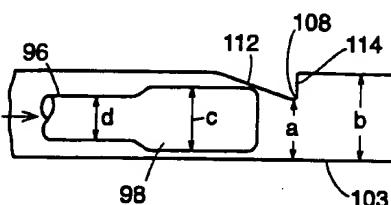
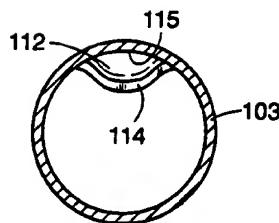
**FIG. 11**



**FIG. 12**



**FIG. 13**



**FIG. 14**

**FIG. 15**